International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 7 Issue 3, May-June 2023 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Use of Granite Waste for the Application as Coarse Aggregate in Concrete

Prof. K. A. Salunke[1], Sumit M. Pardeshi[2], Prathm N. Patil[3], Yash A. Mahajan[4], Lokesh S. Shirode[5]

[1]Assistant Professor, Sandip Foundation's Sandip Institute of Engineering & Management, Nashik, Maharashtra, India
[2,3,4,5]BE Student, Sandip Foundation's Sandip Institute of Engineering & Management, Nashik, Maharashtra, India

ABSTRACT

The granite waste (GW) generated during mining extraction is responsible for environmental degradation. Millions of tonnes of stored granite waste are currently still not being reused. This paper describes a disposal process for this material, where granite waste can be used as alternative aggregate for ordinary concrete. The awareness of the impact of coarse aggregate morphology on the behaviour of fresh concrete mixture, as well as on the deformation and compressive strength of the hardened concrete, favours the creation of the efficiency of Concrete. In this project, experimental work will be done on the effect of granite waste on compressive strength of concrete and split tensile strength of concrete with partial replacement of coarse aggregates by 20%, 40%, 60%, 80%, and 100% for 28 days of water curing for M25 grade of concrete.

This project concluded that the performance concrete made with waste granite as coarse aggregate subjected to water curing is conducted for finding the characteristic mechanical properties such as compressive strength and split tensile of concrete mixtures at 7, 14, and 28 days of curing for 0.45 water-cement ratio. The test results show clearly that waste granite as a partial coarse aggregate has beneficial effects of the mechanical properties of concrete. Of all the 6 mixtures considered, concrete with 20% of granite powder (GW 20%) was found to be superior to other mixtures for all operating conditions. On the other hand, the tensile strength of the concrete reduced with the increment of granite waste. The effect was more significant in the strength of concrete. The study reveals that when waste granite is added in concrete partially replaced with coarse aggregates, the properties of concrete are satisfactory up to 20% of granite waste. But when percentage of granite waste is increases, the compressive strength and split tensile strength of concrete is decreases. The effect of using granite powder in concrete by partially reducing quantities of coarse aggregates reduces cost of concrete work.

How to cite this paper: Prof. K. A. Salunke | Sumit M. Pardeshi | Prathm N. Patil | Yash A. Mahajan | Lokesh S. Shirode "Use of Granite Waste for the Application as Coarse Aggregate in Concrete" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-7 | Issue-3, June 2023, pp.495-502, URL: www.ijtsrd.com/papers/ijtsrd57402.pdf

IJTSRD57402

KEYWORDS: *Concrete, Granite Waste, Coarse Aggregate, Compressive Strength, Split Tensile Strength, etc.*

INTRODUCTION

Granite is a coarse-grained intrusive igneous rock composed mostly of quartz, alkali feldspar, and plagioclase. It forms from magma with a high content of silica and alkali metal oxides that slowly cools and solidifies underground. It is common in the continental crust of Earth, where it is found in igneous intrusions. These range in size from dikes only a few centimeters across to batholiths exposed over hundreds of square kilometers.

Granite is typical of a larger family of granitic rocks, or granitoids, that are composed mostly of coarse-grained quartz and feldspars in varying proportions. These rocks are classified by the relative percentages of quartz, alkali feldspar, and plagioclase (the QAPF classification), with true granite representing granitic rocks rich in quartz and alkali feldspar. Most granitic rocks also contain mica or amphibole minerals, though a few (known as leucogranites) contain almost no dark minerals.

Granite is nearly always massive (lacking any internal structures), hard, and tough. These properties have made granite a widespread construction stone throughout human history. Granites are a type of hard and compact igneous rock formed by quartz, feldspar, as well as mica. Hence, its toughness and durability make it an ideal material for facades. Resistant to heat and cold, this natural stone gives your exterior wall cladding an aspect of strength as well as hardness. Large formats can create continuous surfaces with a timeless style. Granite is resistant to mold and water. It will look great in large or small bathrooms, giving a sense of elegance.

Fig. 1: Granite

Granites are perfect for adding a touch of elegance and shine to interior walls. It enhances the natural look of your home and helps connect indoor and outdoor spaces. A bedroom or a kitchen will completely change their appearance thanks to granite for a mirror effect or natural sensations with honed or aged granites.

The aesthetics of granite is on how it is extracted, processed, and finished. This stone is available in thousands of colors and textures. Granite tends to retain its color and pattern for a very long time so you will have a facade that will last a lifetime.

Granites are the best popular choice stone in the use for domestic and commercial purposes. Granite is stain resistant and durable stone, its wide and colors make the most beautiful stone for a lifetime. R. K. Marbles India is a top leading granite company in India to produce quality and the strongest granites. Our best granite is famous for its combination of beauty and its finishing. Check our website for the best range.

Following are the typical effects of different constituents on the granite colour and appearance:

- Quartz - Milky White Colour
- Feldspar - Off-White Colour
- Potassium Feldspar - Salmon Pink Colour
- Biotite - Black Or Dark Brown Colour
- Muscovite - Metallic Gold Or Yellow Colour
- Amphibole - Black Or Dark Green Colour

A. Physical Properties of Granite

The average density of granite is between 2.65 g/cm^3 and 2.75 g/cm^3 (165 and 172 lb/cu ft), its compressive strength usually lies above 200 MPa, and its viscosity near STP is 3–6·10^{20} Pa.s.

The melting temperature of dry granite at ambient pressure is 1215–1260°C (2219–2300 °F); it is strongly reduced in the presence of water, down to 650 °C at a few hundred mega Pascals of pressure. Granite has poor primary permeability overall, but strong secondary permeability through cracks and fractures if they are present.

B. Chemical Composition of Granite

A worldwide average of the chemical composition of granite, by weight percent, based on analyse. The extrusive igneous rock equivalent of granite is rhyolite.

Table 1: Chemical Composition of Granite

Sr. No.	Type of Chemical	% of Composition
1	SiO_2	72.04% (silica)
2	Al_2O_3	14.42% (alumina)
3	K_2O	4.12%
4	Na_2O	3.69%
5	CaO	1.82%
6	MnO	0.05%
7	FeO	1.68%
8	Fe_2O_3	1.22%
9	MgO	0.71%
10	TiO_2	0.30%
11	P_2O_5	0.12%

C. Granite Waste

Countries around the world have a huge problem with wastes. A large amount of it is still not reused. However, there exists a common tendency to develop new research areas that can deal with this problem. What is more, the tendency to reduce water and using hydrophobic surface impregnants for the protection against harmful environmental impact in concrete technology is more visible in the face of climate change. According to statistics, the construction and mining industries are responsible for more than half of the generated waste in the EU (1.6 trillion tonnes/year). In this area, in the past eighteen years the highest volume of extracted materials was non-metallic minerals. Granite and marble are materials, in which their extraction in just Europe is calculated in a value of millions of tones each year. They are the second most common non-metallic extracted minerals after sand and gravel, and are mostly used as

decorative materials. Before they are ready to be transported to customers, they need to be mechanically treated. During the cutting, shaping and polishing of the blocks, granite dust and coarse aggregate are created as by-products (15–30%). This high amount of unused by-products generates millions of tonnes of waste that needs to be stored. To decrease the negative effects and enhance the disposal of this waste, literature suggests using granite coarse aggregate as a substitute for traditional aggregate.

The extraction of sand and gravel is related to the demand on that product due to the growing industry. Around 75% of concrete is aggregate, and this aggregate plays a huge role in the overall performance of concrete. Thus, there is only one way to decrease granite waste and provide cleaner production. Concrete constructions, which are the most common in the construction industry, can be used to decrease the amount of waste by substituting ordinary aggregate with granite coarse aggregate in order to avoid the negative effect of the environmental degradation that is generated by mining. It is the only industry that could reuse this high amount of the by-aggregate with benefits for the environment, while at the same time enhancing concrete properties. Granite coarse aggregate should be prepared before being used in concrete mixture, and this process may be easier than extracting sand and gravel due to the millions of tonnes of already stored and unused granite waste.

The granite waste is a by-product produced in granite factories while cutting huge granite rocks to the desired shapes. About 3000 metric ton of granite waste is produced per day as a by-product during manufacturing of granite tiles and slabs from the raw blocks. Economic way of stabilization because granite which is available in huge quantity from granite industries. The properties of waste depend upon the granite from which it is taken.

Fig. 2: Granite Waste

D. Granite Waste Aggregates

Extracted granite in a mine is cut into cuboid blocks, and is subsequently sawed and shaped into slabs. During these processes, triangular granite waste is generated, which was used in this study after shaping it into its cubic form. Granite aggregate with a diameter from 20 to 150 mm was used in order to prepare the coarse aggregate. This material was put into a jaw crusher for its fragmentation. The gap of the jaws was 16 mm. Coarse aggregate with a size fraction of diameter from 0 to 16 mm was obtained. In the next step, the gained material was placed in a vibrative screen in order to separate all of the coarse aggregate grains. Then, selected particles with a diameter from 4 to 8 mm were separated, weighed and directed to the vibrative screen in order to choose the narrow size classes.

Sieve analysis was performed using the obtained material. Subsequently, the material was sieved by using slotted sieves with bar space s1 = 2.5 mm, 3.15 mm and 4.0 mm for size fractions with diameter from 4 to 5 mm, diameter from 5 to 6.3 mm and diameter from 6.3 to 8 mm, respectively. This is a standard approach allowing regular and irregular grains in aggregate to be determined. Moreover, the narrow size classes are sieved by using slotted sieves with a bar space equal to half the value of the maximum grain size (dmax/2) in this narrow fraction. In this manner, regular coarse aggregate (RCA) and irregular coarse aggregate (ICA) were obtained.

The regular and irregular grains achieved in the narrow grain grades were combined with each other to obtain the fractions of diameter from 4 to 8 mm needed for making the concrete mixes. The scheme showing the steps in the preparation process of the coarse aggregate is presented in Fig. 3.7. Granite coarse aggregate was used in the research. It was selected for its high mechanical strength and common use as broken aggregate for HPC technology.

Table 2: Characteristics of Granite Coarse Aggregate

Property	Usability Features
Bulk Density ρa [g/cm3]	2.64
Dust Content f [%]	f1,5
Water Absorption WA24 [%]	WA241
Resistant to Freezing/Frost Resistant [%]	F1
Grinding Resistance	LA35
Sulphate Content	AS0,2
Total sulfur	S1

METHODOLOGY

A. Problem Statement

The main objective of this work is to investigate the potential of using granite waste as application as coarse aggregate in concrete. The disposal of granite waste might cause many serious environmental

issues. Due to the low reactivity of this aluminosilicate material in its natural state, granite waste was activated through alkali fusion with different amounts of sodium hydroxide.

B. Aim of the Study

The main aim of the study is to investigate the granite waste used concrete. And the achievement of an acceptable probability that concrete being designed will perform satisfactorily during their intended life. With an appropriate degree of safety, they should sustain all the loads and deformations of normal construction and use and have adequate durability and adequate resistance to the effects of heat. The realization of design objectives requires compliance with clearly defined standards for materials, production, workmanship and also maintenance and use of structure in service.

C. Objectives of the Study

The reported work has aimed at the development and verification of a systematic methodology for process planning and optimization for most efficient method.

The objectives of this study are as follows:

A. To study the effect of granite waste on compressive strength of concrete with partial replacement of coarse aggregates by 20%, 40%, 60%, 80% and 100% for 7, 14 and 28 days of water curing for M25 grade of concrete,
B. To study the effect of granite waste on split tensile strength of concrete with partial replacement of coarse aggregates by 20%, 40%, 60%, 80% and 100% for 7, 14 and 28 days of water curing for M25 grade of concrete,
C. To compare compressive strength of concrete with normal grade of concrete for 7, 14 and 28 days of water curing for M25 grade of concrete. (i. e. 0% of granite waste).

D. Methodology

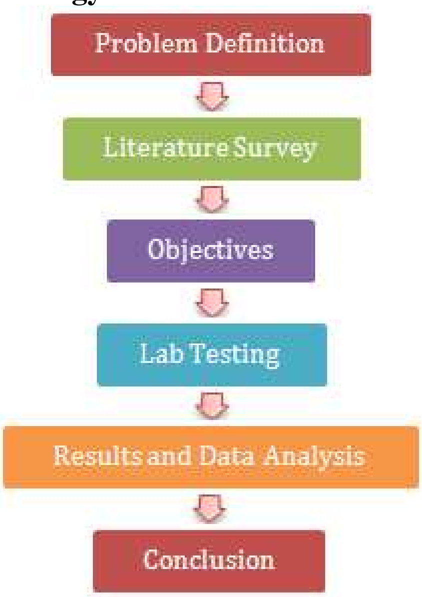


Fig. 3: Methodology

E. Materials

1. Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource.

Materials used for casting concrete specimens consists of Ordinary Portland Cement (OPC) of grade 53 with 28 days compressive strength of 53 MPa, as a binding material provided by Ultratech Cement complying with IS 8112: 2013 (Ordinary Portland Cement 53 Grade - Specifications).

2. Fine and Coarse Aggregates

Aggregate plays an important role in construction. Aggregates influence, to a great extent, the load transfer capability of structure. Hence it is essential that they should be thoroughly tested before using for construction. Not only that aggregates should be strong and durable, they should also possess proper shape and size to make the structure act monolithically.

For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories--fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Natural washed and uncrushed river sand was used as fine aggregate (FA), and as a coarse aggregate (CA) natural crushed basalt was used in saturated surface dry (SSD) condition. In this study maximum nominal size of aggregates was restricted to 10 mm and it is smaller than the one-fourth of the minimum thickness of the specimen and satisfying the IS 456: 2000 (Plain and Reinforced Concrete - Code of Practice) requirement. The density of materials used in this experiment like fine aggregate and coarse aggregate in SSD condition was 2500 kg/m3 and 2600 kg/m3 respectively. Most of the civil engineering projects in India are constructed in concrete with 28 days design compressive strength of 25 MPa. Hence, concrete mix

design was performed for M25 grade of concrete by considering the two different water/cement (W/C) ratios 0.43, 0.45 and 0.47. Cement, fine aggregate and coarse aggregate were mixed in the assistance of distilled water.

3. Water

According to IS 456 : 2000, water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. The pH value of water shall be not less than 6.

EXPERIMENTAL STUDY

A. Properties of Cement

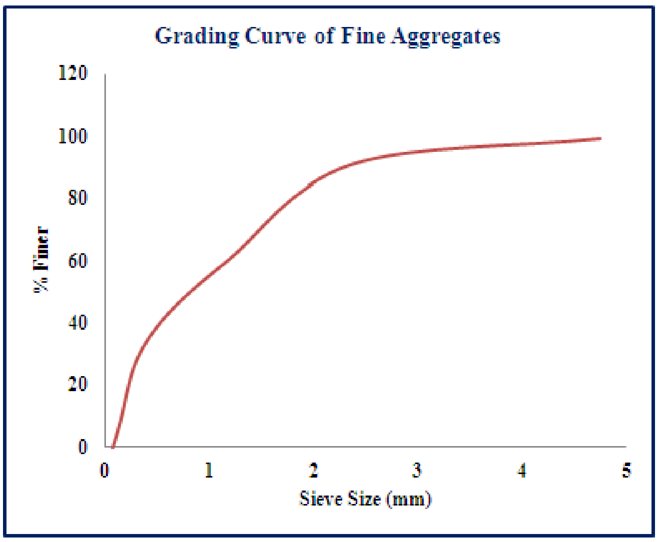
Table 3: Properties of Cement

Sr. No.	Particulars	Value
1	Grade	OPC 33
2	Manufacturer	Ultratech
3	Specific Gravity	2.91
4	Standard Consistency, %	31.5
5	Fineness %	7
6	Initial Setting Time, min	35
7	Final Setting Time, min	600

B. Properties of Fine Aggregates

Table 4: Properties of Fine Aggregates

Sr. No.	Particulars	Values
1	Fineness Modulus	3.318
2	Uniformity Co-efficient	7.33
3	Effective size	0.15
4	Specific gravity	2.59
5	Water absorption (%)	2.67

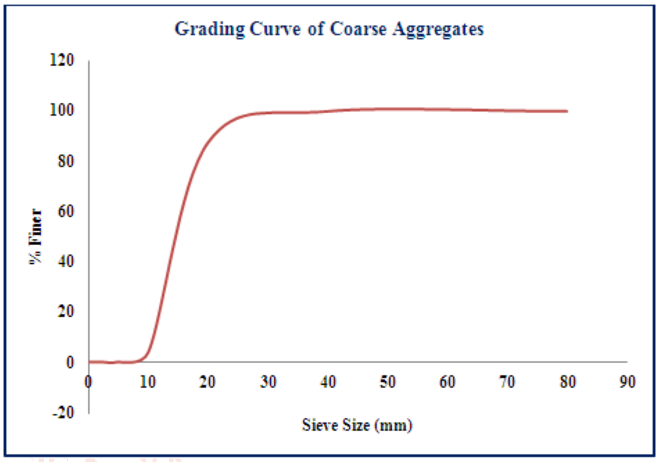


Graph 1: Grading Curve of Fine Aggregates

C. Properties of Coarse Aggregates

Table 5: Properties of Coarse Aggregates

Sr. No.	Particulars	Values
1	Fineness Modulus	7.08
2	Uniformity Co-efficient	1.38
3	Effective size	10.5
4	Specific gravity	2.64
5	Water absorption (%)	0.69
6	Particulars	Values



Graph 2: Grading Curve of Coarse Aggregates

D. Mix Design of Conventional Concrete Grade M25

Table 6: Mix Proportion for Conventional Concrete Grade M25

Sr. No.	Particular	Quantity
1	Cement	350 kg/m^3
2	Fine Aggregates	607.10 kg/m^3
3	Coarse Aggregates	1150 kg/m^3

Cement : Fine Aggregate : Coarse Aggregate = 1 : 1.73 : 3.28

Table 7: Details of Test Specimens

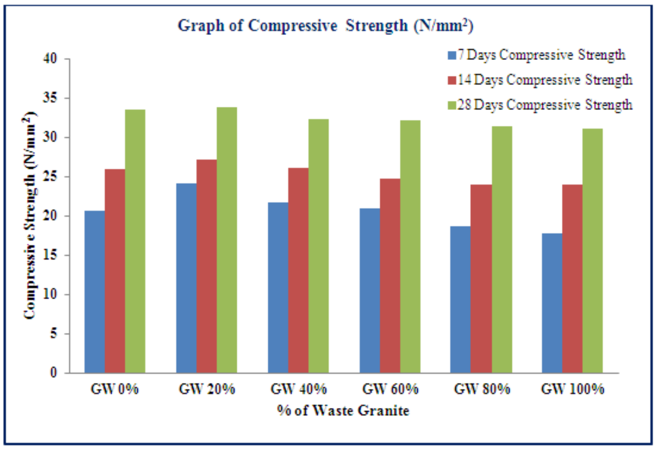
Sr. No.	Specimen & Size	Test	Number
1	Cube 150 x 150	Compressive strength	54
2	Cylinder 150 x 300	Split tensile strength	54

E. Compressive Strength Test Results

Fig. 4: Compressive Strength Test

Table 8: Results of Compressive Strength Test

Sr. No.	% of Waste Granite	Compressive Strength (N/mm^2)		
		7 Days	14 Days	28 Days
1	GW 0%	20.66	25.92	33.47
2	GW 20%	24.15	27.13	33.85
3	GW 40%	21.66	26.06	32.25
4	GW 60%	20.91	24.73	32.16
5	GW 80%	18.63	24.01	31.35
6	GW 100%	17.81	23.95	31.02



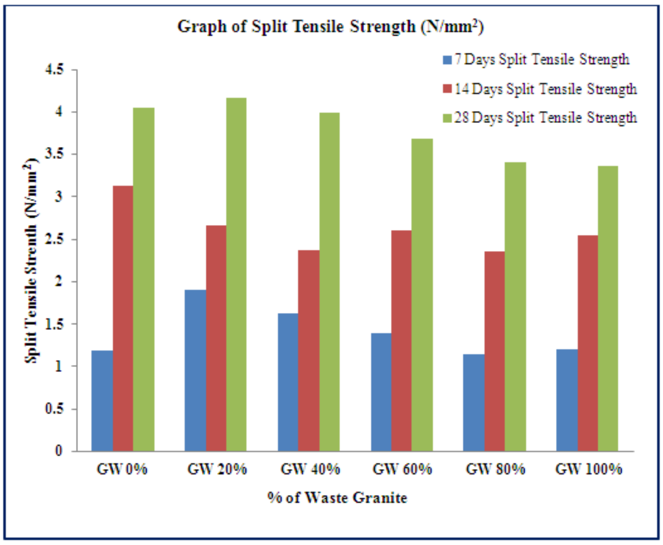
Graph 3: Compressive Strength Results for 7, 14 and 28 Days of Curing with different % of Waste Granite

F. Split Tensile Strength Test Results

Fig. 5: Split Tensile Strength Test

Table 9: Results of Split Tensile Strength Test

Sr. No.	% of Waste Granite	Split Tensile Strength (N/mm^2)		
		7 Days	14 Days	28 Days
1	GW 0%	1.19	3.13	4.05
2	GW 20%	1.90	2.66	4.17
3	GW 40%	1.63	2.37	3.99
4	GW 60%	1.39	2.60	3.68
5	GW 80%	1.15	2.36	3.41
6	GW 100%	1.20	2.55	3.36



Graph 4: Split Tensile Strength Results for 7, 14 and 28 Days of Curing with different % of Waste Granite

CONCLUSION

It can be concluded that:

1. A study on the performance concrete made with waste granite as coarse aggregate subjected to water curing is conducted for finding the characteristic mechanical properties such as compressive strength and split tensile of concrete mixtures at 7, 14, and 28 days of curing for 0.45 water-cement ratio.
2. The test results show clearly that waste granite as a partial coarse aggregate has beneficial effects of the mechanical properties of concrete. Of all the 6 mixtures considered, concrete with 20% of granite powder (GW 20%) was found to be superior to other mixtures for all operating conditions.
3. On the other hand, the tensile strength of the concrete reduced with the increment of granite waste. The effect was more significant in the strength of concrete.
4. The study reveals that when waste granite is added in concrete partially replaced with coarse aggregates, the properties of concrete are satisfactory up to 20% of granite waste. But when percentage of granite waste is increases, the compressive strength and split tensile strength of concrete is decreases.
5. The effect of using granite powder in concrete by partially reducing quantities of coarse aggregates reduces cost of concrete work.

ACKNOWLEDGMENT

At the end of our project, it is a pleasant task to express our thanks to all those who contributed in many ways to the success of this study and made it an unforgettable experience for us. We would like to

express our sincere gratitude to guide **Prof. K. A. Salunke** and co-guide **Prof. A. L. Shimpi** for their excellent guidance and continuous encouragement during course of our work. We truly appreciate for their vast knowledge and delight supervision and advice. Our special thanks to **Prof. K. A. Salunke**, Head of Civil Engineering Department, for his constant inspiration and all the facilities provided to successfully complete this work. We would also like to thank **Dr. D. P. Patil,** Principal of the Institute who has provided us this opportunity to present this dissertation. We would also like to thank to all the faculty members of the department for their valuable guidance and support during the course of our work. Also we would like to thank all our friends who have directly or indirectly helped us in our project work throughout the course. Finally we would like to thank our parents from whom we learnt the value of hard work and its fruitful results.

REFERENCES

[1] Sawekchai Tangaramvong, Peem Nuaklon, May Thazin Khine and Pitcha Jongvivatsakul, *"The Influences of Granite Industry Waste on Concrete Properties with Different Strength Grades"*, Science Direct, Case Studies in Construction Materials 15, August 2021.

[2] Abdulmalek Ahmed, Ahmed Abdulhamid Mahmoud, and Salaheldin Elkatatny, *"The Use of the Granite Waste Material as an Alternative for Silica Flour in Oil-Well Cementing"*, American Chemical Society Omega Publications, *https://dx.doi.org/10.1021/acsomega.0c0426*, December 2020.

[3] Krzysztof Ostrowski, Damian Stefaniuk, Łukasz Sadowski, Kamil Krzywinski, Magdalena Gicala, Magdalena Rozanska, *"Potential Use of Granite Waste Sourced from Rock Processing for the Application as Coarse Aggregate In High-Performance Self-Compacting Concrete"*, Science Direct, Construction and Building Materials 238, 117794, 2020.

[4] M. Venkata Krishna, S. Pravin Thomas, S. Surendar, A. Brahmaiah and P. Krishna Reddy, *"Optimum Utilization of Waste Produced in Granite Mines"*, International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 05, pp. 6443-6446, May 2020.

[5] Abhishek Jain, Rajesh Gupta and Sandeep Chaudhary, *"Sustainable Development of Self-compacting Concrete by using Granite Waste and Fly Ash"*, Science Direct, Construction and Building Materials, Volume 262, 120516, 30 November 2020.

[6] Iman Taji, Saeid Ghorbani, Jorge de Brito, Vivian W. Y. Tam, Sohrab Sharifi, Ali Davoodi and Mohammadreza Tavakkolizadeh, *"Application of Statistical Analysis to Evaluate the Corrosion Resistance of Steel Rebars Embedded in Concrete with Marble and Granite Waste Dust"*, Science Direct, Journal of Cleaner Production, Volume 210, Pages 837-846, 10 February 2019.

[7] R. Thirumalai, Dr. S. Suresh Babu, V. Naveennayak, B. Ragavendra and G. Praveenkumar, *"Stabilization of Black Cotton Soil using Granite Waste and Quarry Dust"*, International Research Journal of Engineering and Technology (IRJET), Volume: 04, Issue: 08, pp. 226-229, August 2017.

[8] L. N. Tchadjié, J. N. Y. Djobo, N. Ranjbar, H. K. Tchakouté, B. B. D. Kenne A. Elimbi and D. Njopwouo, *"Potential of using Granite Waste as Raw Material for Geopolymer Synthesis"*, Science Direct, Ceramics International, Volume 42, Issue 2, Part B, Pages 3046-3055, 1 February 2016.

[9] K. Barani and H. Esmaili, *"Production of Artificial Stone Slabs using Waste Granite and Marble Stone Sludge Samples"*, Journal of Mining & Environment, Volume 7, No.1, pp. 135-141, 2016.

[10] Allam M. E., Bakhoum E. S., Ezz H. and Garas G. L, *"Influence of using Granite Waste on the Mechanical Properties of Green Concrete"*, ARPN Journal of Engineering and Applied Sciences, Volume 11, No. 5, pp. 2805-2811, March 2016.

[11] Suma Paralada, *"Use of Granite Waste as Powder in SCC"*, International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 02, pp.1129-1135, February 2016.

[12] M. Manikandan and Dr. T. Felixkala, *"Experimental Study on Properties of Granite Waste in Self Compacting Concrete"*, Indian Journal of Applied Research, Volume: 5, Issue : 3, pp. 128-130, March 2015.

[13] S. Altaf Hussain, P. Shirisha, T. Shanti Kumar, S. Vamshi Krishna and Suggala. V. Satyanarayana, *"The Use of Granite Industry Waste as a Cement Substitute"*, International Journal of Engineering Research & Technology

(IJERT), Volume 2, Issue 9, pp. 894-898, September 2013.

[14] M. Vijayalakshmi, A. S. S. Sekar, G. Ganesh Prabhu, *"Strength and Durability Properties of Concrete Made with Granite Industry Waste"*, Science Direct, Construction and Building Materials, Volume 46, pp. 1-7, September 2013.

[15] Rania A. Hamza, Salah El-Haggar and Safwan Khedr, *"Marble and Granite Waste: Characterization and Utilization in Concrete Bricks"*, International Journal of Bioscience, Biochemistry and Bioinformatics, Volume 1, No. 4, pp. 286-291, November 2011.